ISSN : 0974 - 7451 Volume 10 Issue 6

Environmental Science
An Indian Journal
Critical Review

ESAIJ, 10(6), 2015 [191-195]

# Cherries, Apples and Sea levels: Discussion of *Neil J.White et al.*, Australian sea levels -trends, regional variability and influencing factors, earth-science reviews 136 (2014) 155–174

**A.Parker[1]*, C.D.Ollier[2]**

[1]School of Aerospace, Mechanical and Manufacturing Engineering, RMIT University, Bundoora 3083 VIC, (AUSTRALIA)
[2]School of Earth and Environment, the University of Western Australia, Crawley 6009 WA, (AUSTRALIA)
E-mail : albert.parker@rmit.edu.au; cliff.ollier@uwa.edu.au

## ABSTRACT

The latest paper of the group led by Church (the leading author of the IPCC AR5 Chapter13 Sea levels) misrepresents sea level multi-decadal oscillations around Australia by cherry-picking the sea level record to produce an accelerating rise in sea level by the stacking of acceleration free records. The paper does not compare apples with apples, but mixesthe reliable sea level records of tide gauges with the unreliable, inaccurate, non-validated computed sea level derived from satellite signals.

## KEYWORDS

Sea levels;
Land motion;
Tide gauges;
Satellite altimetry;
Global positioning system;
Accuracy.

The relative sea level oscillates with periodicities detected up to quasi-60 years all over the world including Australia[1-4]. As all mathematicians know, a sinusoidal oscillation does not have any positive or negative acceleration. But by cherry picking [the land subsidence, phasing of the oscillations and window of the linear analysis in tide gauge records] it is possible to compute by linear regression rates of rise of sea levels much larger or much smaller than is legitimate, just because of the oscillation. The stacking of cherry picked non-accelerating records of different lengths and trends may also produce an accelerating average.

We have alreadycommented on the papers of Church's group proposing the measured relative sea level records for Sydney, Freemantle, San Diego, San Francisco, Seattle, Honolulu and all the other long term tide gauges of the world. As examples the data of Sydney Fort Denison and San Diego, Quarantine Station are reproduced here in Figure 1. Many tide gauges have been recording sea levels for more than a century permitting high quality assessment of any trends. These gauges are often managed by organizationsthat are not obliged to support claims of global warming. Figure 1 a presents the measured monthly average mean sea levels, the fitting of these data with a line and sinuses, and the linear regression analyses of both.

If an experimental distribution $\{x_j,y_j\}$ j=1, …, m represents the m monthly average relative sea level observations $y_j$ at the time $x_j$, the classic estimation of the rate of rise is based on the linear fitting:

$$y^+(x) = \left(y_0^{\ +} + a^+ \cdot x\right) \tag{1}$$

where $y^+$ is the relative sea level, x the time, and $y_0^{\ +}$,$a^+$, are the fitting coefficients. $a^+$ is the relative rate of rise of sea level.

The residual:

$$\varepsilon_j^{+} = y^{+}(x_j) - y_j = \left(y_0^{+} + a^{+} \cdot x_j\right) - y_j \qquad (2)$$

is the error that includes mostly periodical oscillations, noise, fitting inaccuracies or eventually the influence of global warming (if detectable) that would in case produce a departure from the linear trend.

The fitting with a line and sines has the expression:

$$y^{*}(x) = \left(y_0^{*} + a^{*} \cdot x\right) + \sum_{i=1}^{n}\left[A_i \cdot \sin\left(\pi \cdot \frac{x - x_{c,i}}{w_i}\right)\right] \qquad (3)$$

where $y^*$ is the relative sea level, x the time, n the number of sinuses and $y_0^*$, $a^*$, $A_i$, $x_{c,i}$, $w_i$ are the fitting coefficients. $a^*$ is the relative rate of rise, and $A_i$, $x_{c,i}$, $w_i$ are the amplitudes, phases and periods of the oscillations.

The residual

$$\varepsilon_j^{*} = y^{*}(x_j) - y_j = \left(y_0^{*} + a^{*} \cdot x_j\right) + \sum_{i=1}^{n}\left[A_i \cdot \sin\left(\pi \cdot \frac{x_j - x_{c,i}}{w_i}\right)\right] - y_j \qquad (4)$$

is the error that includes noise, fitting inaccuracies, periodic oscillations that are not exactly sinusoidal, periodic oscillations that are not included.

In Sydney, the rate of rise of sea levels is 0.65 mm/year from the linear regression analysis of the measured data and 0.62 mm/year from the linear regression analysis of the fitting with a line and sinuses.

Fitting of the complete distribution $\{x_j, y_j\}$ $j=1, \ldots, m$ with equation (1) returns the rising (or falling) rates already presented in Figure 1.a.

In case equation (3) is used, the sines have different periodicities up to the quasi 60-years detected. It is worth mentioning that oscillations of a given periodicity that are not perfectly sinusoidal may be fitted with a sinusoidal oscillation of same periodicity plus another sinusoidal oscillation of shorter periodicity. The most relevant periodicities are the annual, the quasi-decadal, the quasi-20 years and the quasi-60 years. A longer periodicity is also partially detected. The residual of the fitting, Figure 1.b, is distributed about a zero trend to show inaccuracies of the fitting approach but no increasing rates of rise.

Fitting with equation (1) is the classic approach used to compute the rate of rise (or fall) of the relative sea levels. Rather than using the measured data $\{x_j, y_j\}$ or fitted data $\{x_j, y^*(x_j)\}$ for $j=1, \ldots, m$, with 1 the first recorded month and m the latest, we may also consider at any time $x_k$ the measured or fitted data for $j=k, \ldots, m$. This time series, Figure 1.c, permits us to understand the effect the natural oscillations have on the apparent rate of rise when using short time windows.

Not surprisingly, the rising rate is much larger than is legitimate in Sydney especially with time windows about 20 years [because the early 1990s were a valley of the peak and valley multidecadal oscillations] and not by chance the Australian Baseline Sea Level monitoring project started in that time.

The exercise of stacking short and long tide gauge records to make an average is similarly pointless. Clearly, the Sydney tide gauge is only oscillating. But while a linear regression analysis of the measured data or the data from the fitting curve (3) since 1888 produces relative rates of rise of about 0.6 mm/year, the regression analysis of the data since 1993 produces relative rates of rise three times larger. By stacking the tide gauge records of Sydney since 1888 and Sydney since 1993 one might suppose that there has been a huge acceleration of relative sea levels, but this is wrong because the sea levels of Sydney only oscillate.

It must be borne in mind that the GPS monitoring of the vertical velocity of fixed GPS domes suggests a vertical land motion near the Sydney tide gauge of subsidence, and of about same magnitude of the relative sea level velocity. This indicates that is possibly that the tide gauge is sinking rather than the sea level rising. The vertical land velocity of Sydney (SYDN) near the FORT DENISON 1 & 2 tide gauges is -0.89 ± 0.65 mm/year in[5] and -0.54 ± 0.37 mm/year in[6].

The GPS is used every day by millions of peoples for military, commercial and civil applications. Nevertheless, the GPS based computation of "*fixed*" GPS domes velocities suffersfrom significant unaccuracies with errors not less than ± 2 mm/year. According to theChurch group we should believe that the satellite altimetry can detect the instantaneous velocity of the continuously moving sea surface. The claimed result, even if supported by some carefully selected short term tide gauge records, does not invalidate other tide gauge records, especially the long term records. [The GMSL '*measurements*' are "*continuously calibrated against a network of tide gauges*" but the GMSL "*cannot be used to predict relative sea level changes along the*

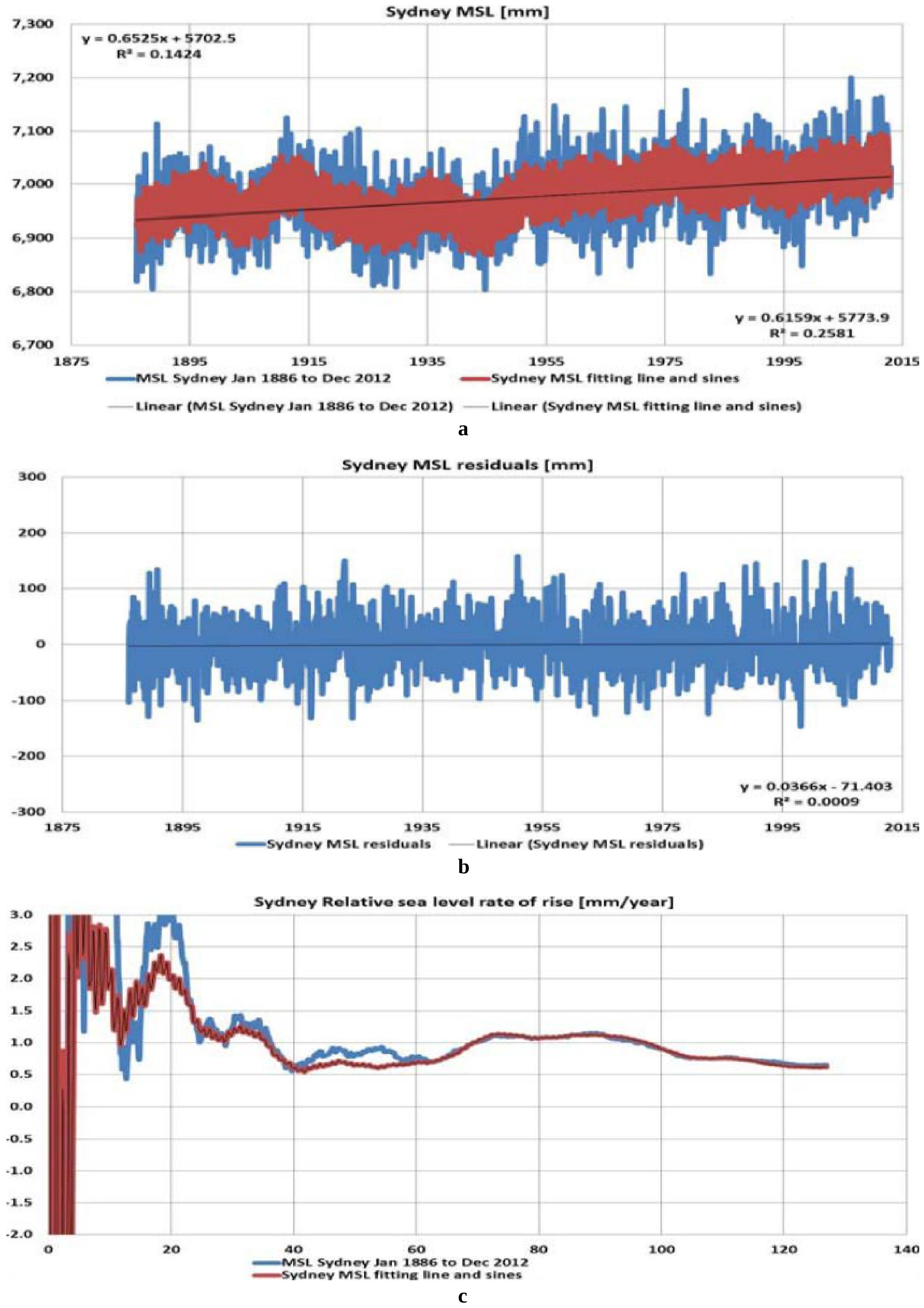
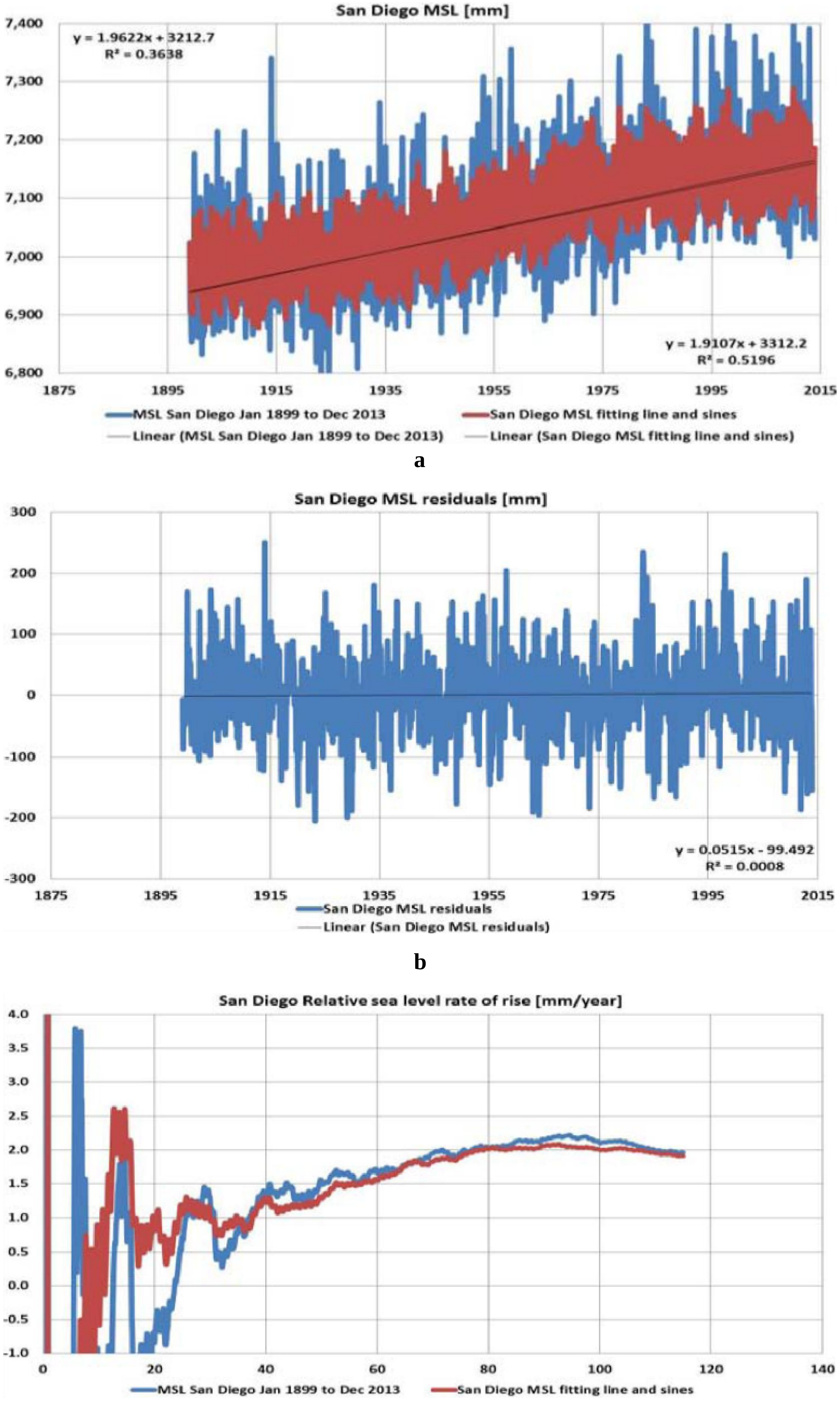


**Figure 1 : (continues)– Relative mean sea levels in Sydney: a: Measured monthly average mean sea levels and their fitting with a line and sinuses; b: Residuals of the fitting; c: Rates of relative sea level rise from the measured or fitted data with time windows of different length up to the present time.**



a

b

c

**Figure 1 : (continued) - Relative mean sea levels in San Diego: a: Measured monthly average mean sea levels and their fitting with a line and sinuses; b: Residuals of the fitting; c: Rates of relative sea level rise from the measured or fitted data with time windows of different length up to the present time.**

*coasts*". "*We do calibrate the altimeter sea level measurements against a network tide gauges to discover and monitor drift in the satellite (and sometimes tide gauge) measurements*"[7].]

As already commented many times[8,9] the satellite GMSL is not a measurement but a computation. The raw satellite altimeter signal is only noise about a zero trend. So it is only the correction that produces the alleged 3.2 ± 0.4 mm/year of rise.

For the lovers of the hot spot of positive accelerations, the sea levels oscillate in time and space, and if on the east coast of a basin there is a positive phase, sometimes on the west coast there is a negative phase. Figure 1 also presents the results for San Diego, Quarantine station in addition to Sydney, Fort Denison. The vertical land velocity of Point Loma 3 (PLO3) near the SAN DIEGO (QUARANTINE STATION) tide gauge is -1.65 ± 0.41 mm/year in[5] vs. -2.39 ± 1.00 mm/year in[6]. In[5], the vertical land velocity of PLO5 nearby PLO3 is -3.23 ± 0.17 mm/year. Therefore, there is subsidence about same order of magnitude of relative sea level rate of rise also in San Diego.]

The long-term global tide gauge network[10] does not exhibit any positive acceleration; only oscillations about a constant rate of rising trend[1-4]. The latest (update 14-Feb-2014) "*Table of Relative Mean Sea Level Secular Trends*" includes the relative sea level rates of rise for 560 individual locations along the coast mostly in the northern hemisphere and mostly in areas of subsidence. The number of years of data used to compute the trend, the range of years used and the relative sea level trend vary considerably from one location to the other where subsidence or uplift, quality and length of the record and other factors affect the computed trend. For the establishment of meaningful long-term trends, only the 170 stations with more than 60 years of data are considered, and for these stations, the average relative sea level trend is +0.403 mm/year[9]. Subsequent updates of compilations of tide gauges of sufficient quality and length not only verify that the average relative sea level trend is low and very close to zero, but also indicate that the time rate of change of this velocity is zero, so there is no*sea level acceleration*.

So far as Australia is concerned, the correct analysis of the tide gauges[1] suggests the lack of any acceleration and possible rates of rise are anything but dramatic, on average below 1 mm/year, and mostly related to the subsidence of the coast.

## REFERENCES

**[1]** A.Parker; Natural oscillations and trends in long-term tide gauge records from the pacific. Pattern Recogn. Phys. doi:10.5194/prp-1-1-2013, **1**, 1-13 **(2013)**.

**[2]** A.Parker, M.SaadSaleem, M.Lawson; Sea-level trend analysis for coastal management. Ocean and Coastal Management, **73**, 63-81 **(2013)**.

**[3]** A.Parker; Sea level trends at locations of the United States with more than 100 years of recording. Natural Hazards, **65(1)**, 1011-1021, **(2013)**.

**[4]** A.Parker; Oscillations of sea level rise along the Atlantic coast of North America north of Cape Hatteras. Natural Hazards, **65(1)**, 991-997 **(2013)**.

**[5]** http://www.sonel.org

**[6]** http://sideshow.jpl.nasa.gov/post/series.html

**[7]** http://sealevel.colorado.edu/

**[8]** N.A.Mörner; Estimating future sea level changes from past records. Global and Planetary Change, **40(1-2)**, 49-54 **(2004)**.

**[9]** A.Parker; Problems and reliability of the satellite altimeter based Global Mean Sea Level computation Pattern Recogn. Phys. **(2014)**.

**[10]** http://www.psmsl.org